

CLAIMS

1. A phosphorus-containing polymer, comprising the reaction product of an unsaturated phosphonic acid with a chain-transfer agent, the polymer having improved biodegradability as compared to the same polymer when made in the absence of the chain-transfer agent.
2. A polymer according to Claim 1, the polymer having a biodegradability of at least 20% per 28 days (as determined by OECD 306).
3. A polymer according to Claim 1, in which the chain-transfer agent is benzene, toluene, ethylbenzene or chlorobenzene.
4. A polymer according to Claim 1, in which the chain-transfer agent is methylene chloride, ethylene chloride, chloroform or carbon tetrachloride.
5. A polymer according to Claim 1, in which the chain-transfer agent is acetone, thiophenol, n-butyl thiol or dodecyl thiol.
6. A phosphorus-containing polymer comprising the reaction product of a chain-transfer agent having at least one P-H bond with an unsaturated carboxylic, phosphonic or sulphonic acid, the polymer having a biodegradability of at least 20% per 28 days (as determined by OECD 306).
7. A polymer according to Claim 6, having phosphorus-containing end-caps and comprising the reaction product of a chain-transfer agent having at least one P-H bond with an unsaturated carboxylic, phosphonic

or sulphonic acid, said polymer having a biodegradability of at least 20% per 28 days (as determined by OECD 306).

5 8. A polymer according to Claim 6 or 7, in which the chain-transfer agent having at least one P-H bond is hypophosphorous acid or a water-soluble salt of said acid.

9. A polymer according to Claim 8, in which the chain-transfer agent is an alkali metal salt or an ammonium salt of hypophosphorous acid.

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10. A polymer according to any one of Claims 6 to 9, in which the unsaturated carboxylic acid is acrylic acid or a water-soluble salt of said acid.

15 11. A polymer according to any one of Claims 6 to 9, in which the unsaturated carboxylic acid is methacrylic acid, maleic acid, fumaric acid, itaconic acid, aconitic acid, citraconic acid, mesaconic acid, crotonic acid, isocrotonic acid, angelic acid, tiglic acid or a water-soluble salt of any of said acids.

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12. A polymer according to Claim 1 or to any one of Claims 6 to 9, in which the unsaturated phosphonic acid is vinylphosphonic acid (VPA), vinylidene-1,1-diphosphonic acid (VDPA) or a water-soluble salt of either of said acids.

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13. A polymer according to any one of Claims 6 to 9, in which the unsaturated sulphonic acid is vinylsulphonic acid (VSA) or a water-soluble salt of said acid.

14. A polymer according to any one of Claims 1 to 10, comprising a telomer which is the reaction product of a PPE-endcapper (as hereinbefore defined) with acrylic acid.

5 15. A polymer according to Claim 14, in which the ratio of the PPE-endcapper to acrylic acid is in the range 1:5 to 1:20 molar.

16. A polymer according to Claim 14 or 15, in which the ratio of the PPE-endcapper to acrylic acid is about 1:10 molar.

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17. A polymer according to any one of Claims 1 to 16, in which at least 20% by weight of the polymer has a weight average molecular weight of 1000 or lower.

15 18. A polymer according to Claim 17, in which at least 35% by weight of the polymer has a weight average molecular weight of 1000 or lower.

19. A method of making a polymer according to any one of Claims 1 to 18, in which the chain-transfer agent and the unsaturated acid are
20 reacted together in the presence of a free-radical initiator.

20. A method according to Claim 19, in which the free-radical initiator is an alkali metal persulphate.

25 21. A method according to Claim 20, in which the free-radical initiator is sodium persulphate.

22. A method according to Claim 19, in which the free-radical initiator is an alkali metal peracetate, hydrogen peroxide, a hydroperoxide,
30 chlorine dioxide, an alkali metal chlorate or hypochlorite, an

organometallic hydride, an azo-compound or any two or more of the foregoing.

23. A method according to Claim 22, in which the free-radical initiator
5 is 4,4'-azo-bis-cyanovaleric acid.

24. A method according to Claim 19, in which the free-radical initiator
comprises electrolysis, ultraviolet or other ionising radiation, ultrasound
or any two or more of the foregoing.
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25. A method of making a biodegradable polymer, substantially as
hereinbefore described with reference to the Examples.

26. A phosphorus-containing polymer comprising the reaction product
15 of a chain transfer agent with an unsaturated carboxylic, phosphonic or
sulphonic acid, the polymer having improved biodegradability as
compared to the same polymer when made in the absence of the chain-
transfer agent.

20 27. A phosphorus-containing polymer as claimed in Claim 25 having
phosphorus-containing end caps.

28. A biodegradable polymer as claimed in Claims 1 to 18, 26 and 27
made by the method of any one of Claims 19 to 25.
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29. The use of a biodegradable polymer according to any one of
Claims 1 to 18, 26 and 27 as a scale-inhibitor for oilfield applications.